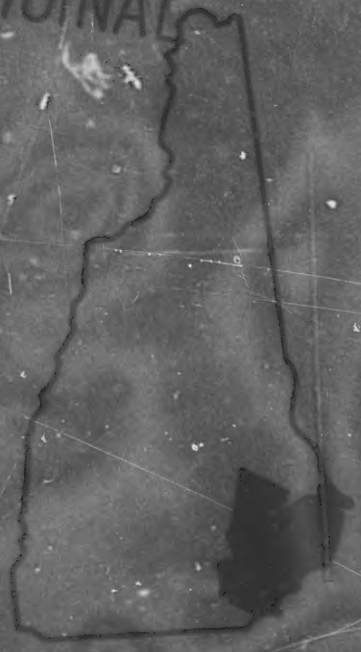
MAY 9 1986 COMPLETED

FEM 1.209:330135

FLOOD INSURANCE STUDY

ORIGINAL

TOWN OF NEW CASTLE, NEW HAMPSHIRE
ROCKINGHAM COUNTY



AUGUST 5, 1986

Federal Emergency Management Agency

COMMUNITY NUMBER 330138

BEST COPY AVAILABLE

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
	1.1 Purpose of Study	1
	1.2 Authority and Acknowledgments	1
	1.3 Coordination	1
2.0	AREA STUDIED	2
	2.1 Scope of Study	2
	2.2 Community Description	2
	2.3 Principal Flood Problems	4
	2.4 Flood Protection Measures	4
3.0	ENGINEERING METHODS	4
	3.1 Hydrologic Analyses	6
	3.2 Hydraulic Analyses	8
4.0	FLOOD PLAIN MANAGEMENT APPLICATIONS	10
	4.1 Flood Boundaries	10
5.0	INSURANCE APPLICATION	12
	5.1 Reach Determinations	12
	5.2 Flood Hazard Factors	12
	5.3 Flood Insurance Zones	13
	5.4 Flood Insurance Rate Map Description	14

TABLE OF CONTENTS - continued

	Page
6.0 OTHER STUDIES	14
7.0 LOCATION OF DATA	14
8.0 BIBLIOGRAPHY AND REFERENCES	15

FIGURES

Figure 1 - Vicinity Map	3
Figure 2 - Flood Photograph Following February 1978 Northeaster	5
Figure 3 - Transect Location Map	11

TABLES

Table 1 - Summary of Stillwater Elevations	7
Table 2 - Flood Insurance Zone Data	13

EXHIBITS

Exhibit 1 - Coastal Profiles
Transects 1-2 Panels 01C - 02C

Exhibit 2 - Flood Insurance Rate Map Index
Flood Insurance Rate Map

FLOOD INSURANCE STUDY
TOWN OF NEW CASTLE, NEW HAMPSHIRE

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Town of New Castle, Rockingham County, New Hampshire, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in their efforts to promote sound flood plain management. Minimum flood plain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were prepared by Stone & Webster Engineering Corporation for the Federal Emergency Management Agency (FEMA), under Contract No. H-4772. This work was completed in April 1984.

1.3 Coordination

On April 19, 1978, an initial Consultation and Coordination Officer's (CCO) meeting was held with representatives of FEMA, the Town of New Castle, and Stone & Webster Engineering Corporation (the study contractor). Coordination with town officials and federal, regional, and state agencies produced a variety of information pertaining to flood plain regulations, available community maps, past flood history, and other hydrologic data.

Analyses of Atlantic Ocean flood levels were coordinated with the U. S. Army Corps of Engineers (COE) and the National Oceanic and Atmospheric Administration. The Massachusetts Department of Public Works provided

BEST COPY AVAILABLE

information on historic flooding and high-water marks. Vertical control data used to establish the network of elevation reference marks were provided by the New Hampshire Department of Public Works and Highways, the U. S. Geological Survey (USGS), the National Oceanic and Atmoshpheric Administration, and the U. S. Coast & Geodetic Survey (USC&GS).

An intermediate CCO meeting was conducted on May 21, 1979, to present the results of a study for New Castle, which contained solely a stillwater flooding analysis, to town officials. Prior to the publication of that study, FEMA decided to add the effects of wave action. The results of the wave action analysis were submitted to the town by letter on April 10, 1984. On January 21, 1985, the results of the study were reviewed at a final CCO meeting attended by representatives of FEMA, the town, and the study contractor.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the Town of New Castle, Rockingham County, New Hampshire. The area of study is shown on the Vicinity Map (Figure 1).

Tidal flooding including its wave action from the Atlantic Ocean was studied by detailed methods. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction through April 1989.

2.2 Community Description

The Town of New Castle is located in Rockingham County in southeastern New Hampshire, approximately 1 mile east of Portsmouth and 55 miles north of Boston, Massachusetts. It is bordered by the Atlantic Ocean to the east, the Town of Rye to the south, the City of Portsmouth to the west, and the Town of Kittery, Maine, to the north.

New Castle is an island residential community. According to the 1976 state census, New Castle had a population of 870 and a population density of 1,088 per square mile; its 1976 population increased 5.2 percent from its 1970 population of 827 (Reference 1). Town officials estimated the 1980 population at 937. It is expected that the population of the town will increase by approximately 31 percent between 1976 and 1990 (Reference 2).

The total land area contained within the corporate limits of New Castle is 0.8 square mile. Access is via two roads from Portsmouth and Rye. The island is a popular summer resort, with residential development along

BEST COPY AVAILABLE

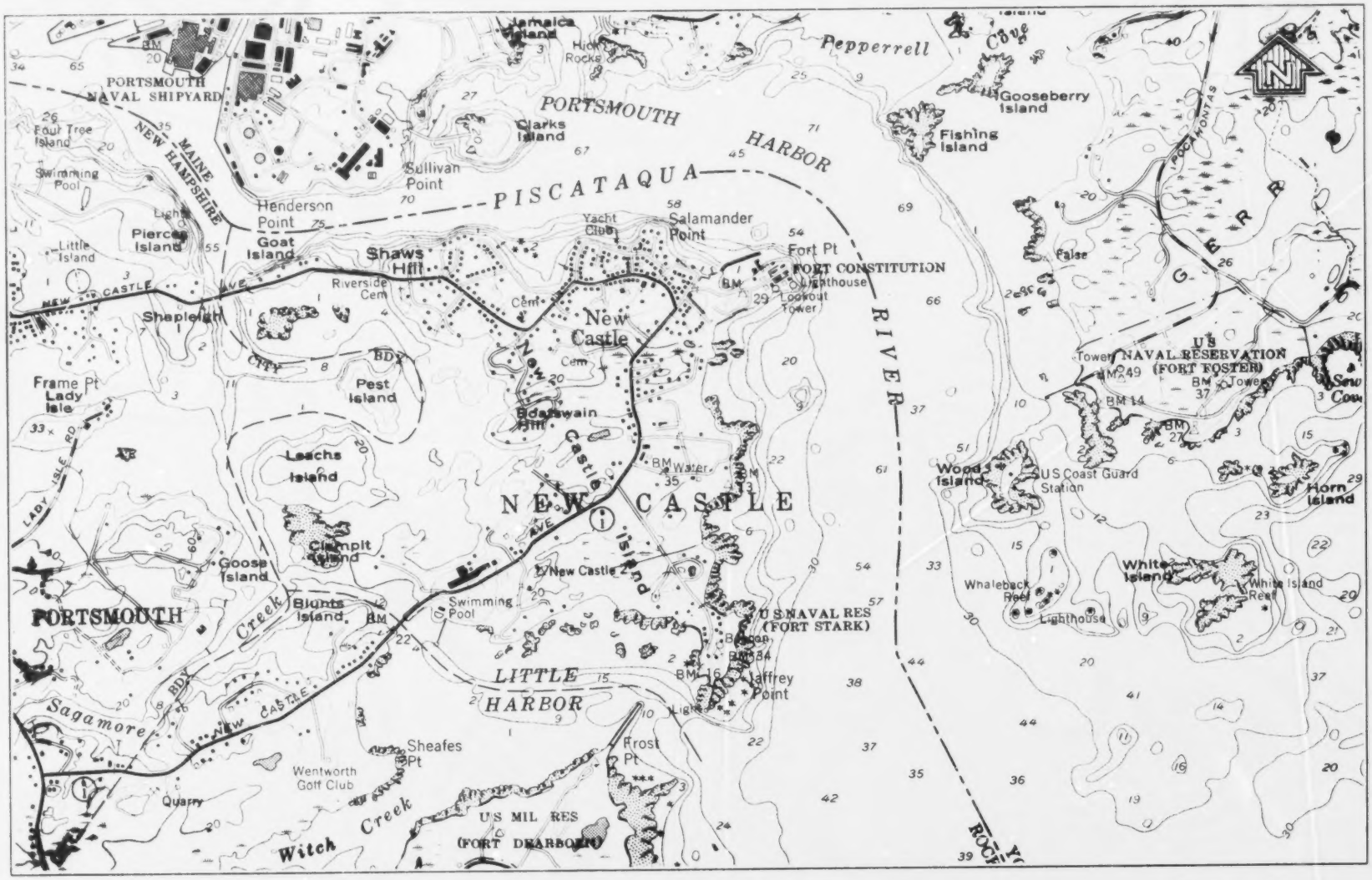


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NEW CASTLE, NH

(ROCKINGHAM CO.)

APPROXIMATE SCALE

2000 0 2000 4000 8000 FEET

VICINITY MAP

BEST COPY AVAILABLE

the coast. A large resort hotel is located at the west end of the island. The coast of New Castle is irregular and is characterized by rocky ledges along its eastern shore. There are scattered small islands offshore (Reference 3).

Topographically, the island of New Castle is relatively flat. Elevations range from sea level to 60 feet.

New Castle has a variable climate. The average annual precipitation is approximately 43 inches. There is no dry season. From June to September, rainfall usually occurs as showers or thunderstorms. Throughout the year, the heaviest gales are usually from the northeast or east and are more common and severe during the winter. The coastal northeasters produce an abundance of rain and snow. The average annual temperature is in the mid-forties (Reference 4).

2.3 Principal Flood Problems

The low-lying coastal areas of New Castle are subject to the periodic flooding and wave attack that accompany coastal storms, such as northeasters and hurricanes. The majority of these storms cause damage only to low coastal roads, boats, beaches, and revetments. Occasionally, a major storm accompanied by strong onshore winds and high tides results in surge and wave activity that causes property damage and erosion. Some of the more significant storms in the New Castle area include those of December 1909 and 1959 (approximately 160- and 15-year recurrence intervals, respectively) and February 1972 and 1978 (approximately 10- and 70-year recurrence intervals, respectively).

Figure 2 shows flood damage in New Castle from the February 1978 northeaster.

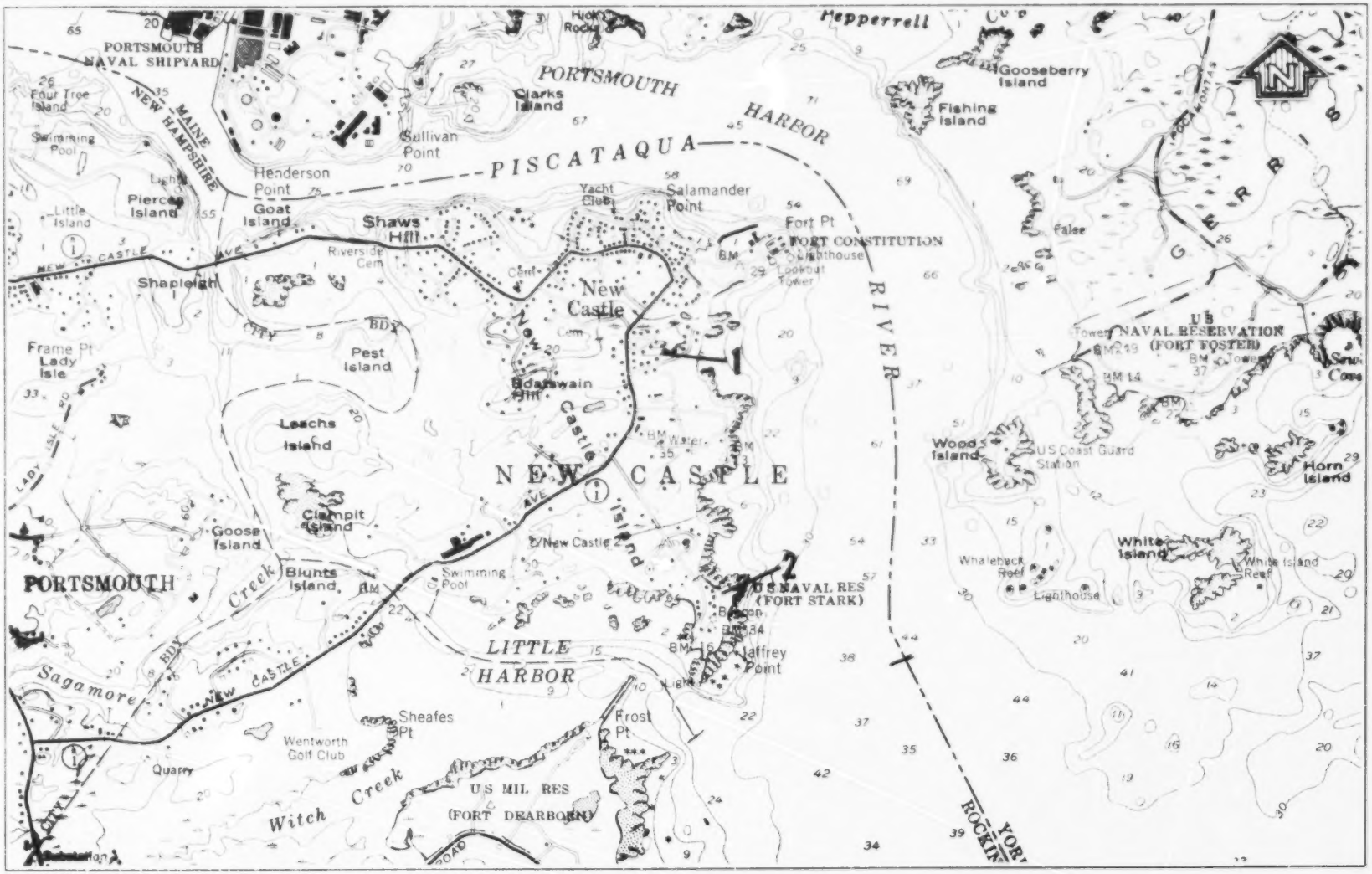
2.4 Flood Protection Measures

The Town of New Castle has no major flood protective structure within its corporate limits. A breakwater located in Rye that is maintained by the COE does provide some protection for Little Harbor. There are some small-scale protective structures maintained by private homeowners that satisfy individual requirements. The principal form of flood protection in New Castle has been sound flood plain management.

3.0 ENGINEERING METHODS

For the flooding source studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard

BEST COPY AVAILABLE



FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NEW CASTLE, NH

(ROCKINGHAM CO.)

APPROXIMATE SCALE

2000 0 2000 4000 8000 FEET

TRANSECT LOCATION MAP

FIGURE 3

BEST COPY AVAILABLE

data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Analyses were carried out to establish the peak elevation-frequency relationships for the flooding source studied in detail affecting the community.

In New England, the flooding of low-lying coastal areas is caused primarily by storm surges generated by extratropical coastal storms called northeasters. Hurricanes also occasionally produce significant storm surges in New England, but they occur infrequently as compared to northeasters.

To calculate the storm surge and total stillwater elevations produced by historic storms, it was necessary to determine the storm pressure and wind fields. A computer model was developed by the study contractor to simulate these fields based on several, easily obtained, northeaster storm parameters. A detailed description of this model is presented in the report entitled Development and Verification of a Synthetic Northeaster Model for Coastal Flood Analysis (Reference 5). A different model was used to simulate the wind and pressure fields of the hurricanes considered in this analysis (Reference 6). When coupled with a computer surge model, the storm tide along the shoreline could be calculated for each storm of interest.

Synoptic weather maps were searched to determine the northeasters and hurricanes that could potentially produce significant flooding in the New Castle area. Tidal records from tide gages in the New England area were examined to verify which historic storms produced high-water elevations. A total of 165 storms, from 1942 to 1978, was considered in the analysis of flood levels.

BEST COPY AVAILABLE

The flood levels associated with historic storms were simulated using a modified version of the FEMA storm surge model (References 7 and 8). Input to the model consisted of wind and pressure fields generated either by the synthetic northeaster model or a hurricane wind and pressure field model for each historic storm selected. The study area was modeled using a square grid of sufficient resolution to accurately represent the offshore bathymetry and shoreline configuration. The grid mesh covered an area from Cape Cod Bay to north of Portsmouth, New Hampshire, including Boston Harbor. Output from the model included the time history of storm-induced surge elevations in the study area. These elevations were combined with the predicted astronomical tide for the same time period to produce total stillwater elevations for the communities in the study area. The total stillwater elevation was calibrated using historic tide elevation data at Boston, Massachusetts, and Portsmouth, New Hampshire. Thus, the historic storm-induced flood levels in New Castle could be simulated for each storm considered in the analysis.

The extent and frequency of recurrence of coastal flooding were determined by conducting a frequency analysis of annual maximum tidal heights along the coastline of New Castle. Some historic stillwater heights, consisting of an astronomical tide and a storm surge contribution, were determined by the mathematical simulation of historic northeasters and hurricanes as described above; others, for which associated storm data were not available, were obtained by a correlation analysis using tide data from Boston or Portsmouth. The data base at the Boston gage extended from 1978 discontinuously back to 1848; the shorter record at Portsmouth was lengthened by a statistical correlation with data at Boston and Portland. The annual maxima of these reproduced historic stillwater elevations were fitted with a Pearson Type III distribution. The goodness of fit was tested with the chi-square test and accepted at the 95 percent confidence level. A detailed description of the methodology employed in this analysis can be found in the report entitled Determination of Coastal Storm Tide Levels (Reference 8).

The stillwater elevations for the 10-, 50-, 100-, and 500-year floods have been determined for the Atlantic Ocean and are summarized in Table 1.

TABLE 1 - SUMMARY OF STILLWATER ELEVATIONS

FLOODING SOURCE AND LOCATION	ELEVATION (feet) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
ATLANTIC OCEAN				
Entire shoreline within community	8.2	8.9	9.2	9.8

BEST COPY AVAILABLE

The analyses reported in this study reflect the stillwater elevations due to tidal and wind setup effects. The effects of wave action were also considered in the determination of flood hazard areas. Coastal structures which are located above stillwater flood elevations can still be severely damaged by wave runup, wave-induced erosion, and wave-borne debris. For example, during the February 1978 northeaster, considerable damage along the New Hampshire coast was caused by wave activity, even though most of the damaged structures were above the high-water level. The extent of wave runup past stillwater levels depends greatly on the wave conditions and local topography.

Wave heights and corresponding wave crest elevations were determined using the National Academy of Sciences (NAS) methodology (Reference 9). The wave runup was determined using the methodology developed by Stone & Webster Engineering Corporation for FEMA (Reference 10).

3.2 Hydraulic Analyses

Hydraulic analyses, considering storm characteristics and the shoreline and bathymetric characteristics of the flooding source studied, were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along the shoreline.

Areas of coastline subject to significant wave attack are referred to as coastal high hazard zones. The COE has established the 3-foot breaking wave as the criterion for identifying the limit of coastal high hazard zones (References 11 and 12). The 3-foot wave has been determined as the minimum size wave capable of causing major damage to conventional wood frame or brick veneer structures.

A wave height analysis was performed to determine wave heights and corresponding wave crest elevations for the areas inundated by the tidal flooding. A wave runup analysis was performed to determine the height and extent of runup beyond the limit of tidal inundation. The results of these analyses were combined into a wave envelope, which was constructed by extending the maximum wave runup elevation seaward to its intersection with the wave crest profile.

The methodology for analyzing wave heights and corresponding wave crest elevations was developed by the NAS (Reference 9). The NAS methodology is based on three major concepts.

First, a storm surge on the open coast is accompanied by waves. The maximum height of these waves is related to the depth of water by the following equation:

$$H_b = 0.78d$$

BEST COPY AVAILABLE

where H_b is the crest to trough height of the maximum or breaking wave and d is the stillwater depth. The elevation of the crest of an unimpeded wave is determined using the equation:

$$Z_w = S_* + 0.7H_* = S_* + 0.55d$$

where Z_w is the wave crest elevation, S_* is the stillwater elevation at the site, and H_* is the wave height at the site. The 0.7 coefficient is the portion of the wave height which reaches above the stillwater elevation. H_b is the upper limit for H_*.

The second major concept is that the breaking wave height may be diminished by dissipation of energy by natural or man-made obstructions. The wave height transmitted past a given obstruction is determined by the following equation:

$$H_t = BH_i$$

where H_t is the transmitted wave height, H_i is the incident wave height, and B is a transmission coefficient ranging from 0.0 to 1.0. The coefficient is a function of the physical characteristics of the obstruction. Equations have been developed by the NAS to determine B for vegetation, buildings, natural barriers such as dunes, and man-made barriers such as breakwaters and seawalls (Reference 9).

The third concept deals with unimpeded reaches between obstructions. New wave generation can result from wind action. This added energy is related to distance and mean depth over the unimpeded reach.

The methodology for analyzing wave runup was developed by Stone and Webster Engineering Corporation (Reference 10). The wave runup computer program operates using an ensemble of deepwater wave heights, H_i, the stillwater elevation, S*, a wave period, T_s, and beach slope, m. For New Castle, wave heights range from 5 feet up to the significant wave height of 30 feet; the wave period equals 14 seconds.

These concepts and equations were used to compute wave envelope elevations associated with the 100-year storm surge. Accurate topographic, land-use, and land cover data are required for the coastal analyses. Maps of the study area, at a scale of 1:2,400 with a contour interval of 5 feet, were used for the topographic data (Reference 13). The land-use and land cover data were obtained by field surveys.

Wave heights and wave runup were computed along transects which were located perpendicular to the average mean shoreline. The transects were

BEST COPY AVAILABLE

located with consideration given to the physical and cultural characteristics of the land so that they would closely represen conditions in their locality. Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, the transects were spaced at larger intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects. Figure 3, "Transect Location Map," illustrates the location of the transects for the community.

Along each transect, wave envelope elevations were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. Between transects, elevations were interpolated using the topographic maps, land-use and land cover data, and engineering judgment to determine the areal extent of flooding. The results of the calculations are accurate until local topography, vegetation, or cultural development within the community undergo any major changes. The selected beach transects with wave envelope profiles for the 10- and 100-year recurrence intervals are shown on the Coastal Profiles (Exhibit 1).

In some locations, water levels shown on the maps were computed by correlating synthetically produced water levels with elevations obtained during historic floods (Reference 14). Historic flood damage information was also used to ensure reasonable delineation of flood-prone areas along the New Castle shoreline.

All elevations used in this study are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used are shown on the maps.

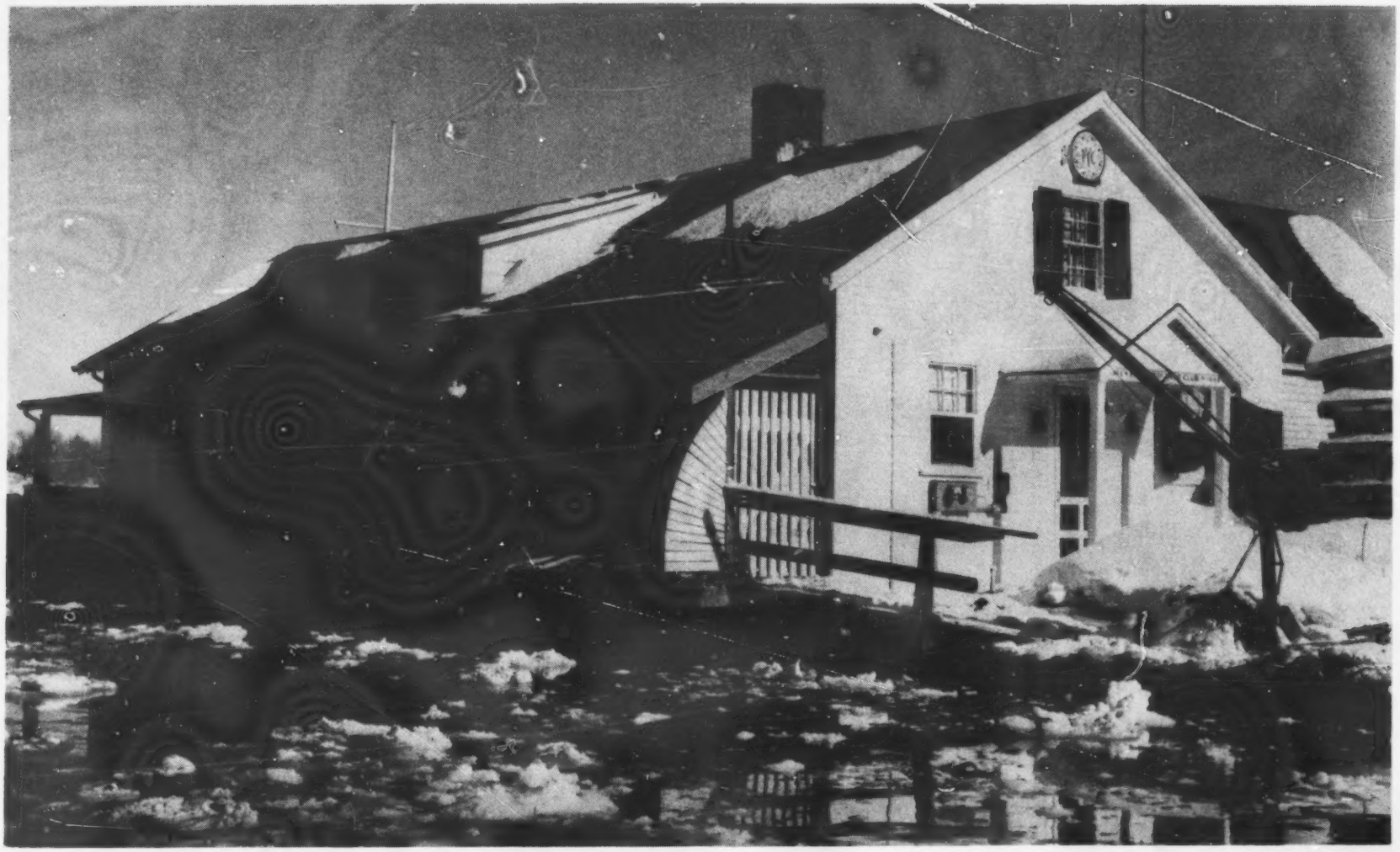
4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages State and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing flood plain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for flood plain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood

BEST COPY AVAILABLE



BEST COPY AVAILABLE

Figure 2. Damage to pier at the Portsmouth Yacht Club caused by the northeaster of February 6-8, 1978.

risk in the community. For tidal areas without wave action, the 100-year and 500-year boundaries were delineated using topographic maps at a scale of 1:2,400 with a contour interval of 5 feet (Reference 13). For the tidal areas with wave action, the flood boundaries were delineated using the elevations determined at each transect; between transects, the boundaries were interpolated using engineering judgment, land-cover data, and the topographic maps referenced above. The 100-year flood plain was divided into whole-foot elevation zones based on the average wave envelope elevation in that zone. Where the map scale did not permit these zones to be delineated at one foot intervals, larger increments were used.

The 100- and 500-year flood plain boundaries are shown on the Flood Insurance Rate Map (Exhibit 2). In cases where the 100- and 500-year flood plain boundaries are close together, only the 100-year flood plain boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for the flooding source studied in detail in the Town of New Castle.

5.1 Reach Determinations

Reaches are defined as sections of flood plain that have relatively the same flood hazard. In areas where wave height and wave runup analyses were performed, reaches were determined for areas of the coastline, represented by a transect or group of transects, which have the same physical characteristics. For each transect the coastal high hazard zone (V zone) may be divided into two reaches to reflect those areas where wave runup is a dominant factor and those areas where wave runup does not dominate and elevations are determined by the wave height analysis. The reaches determined for the Town of New Castle are summarized in Table 2.

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

BEST COPY AVAILABLE

TABLE 2 - FLOOD INSURANCE ZONE DATA

Flooding Source	Stillwater Elevation 10-Year	Stillwater Elevation 100-Year	FHF	Zone	Base Flood Elevation (Feet NGVD)*
Atlantic Ocean	8.2	9.2	015	V3	13-14
			010	V2	11-18
			010	A2	9-13

*Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one-half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF, and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zone A2: Special Flood Hazard Areas inundated by the 100-year flood; with base flood elevations shown, and zones subdivided according to FHFs.

Zone V2 and V3: Special Flood Hazard Areas along coasts inundated by the 100-year flood that have additional velocity hazards associated with waves of 3-foot amplitude or greater; with base flood elevations shown, and zones subdivided according to FHFs.

Zone B: Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other water control structure; areas subject to certain types of 100-year shallow flooding

BEST COPY AVAILABLE

Zone B: (continued) — where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.

Zone C: — Areas of minimal flooding; not subdivided.

Flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the flooding source studied in detail in the community are shown in Table 2.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the Town of New Castle is, for insurance purposes, the principal result of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevations. Base flood elevation lines show the locations of the expected whole-foot water-surface elevation of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the National Flood Insurance Program.

6.0 OTHER STUDIES

Using National Ocean Survey tide gage data, the COE predicted 10-, 50-, 100-, and 500-year flood levels at Boston, Massachusetts, and Portsmouth, New Hampshire. Their results compare favorably with flood elevations determined in this study considering the distance between New Castle and the National Ocean Survey gaging stations.

The Flood Insurance Studies for City of Portsmouth and the Town of Kittery have been published (References 15 and 16). The results of those studies are in complete agreement with the results of this study for New Castle.

The Flood Insurance Study for the Town of Rye is currently being prepared (Reference 17). The results of that study will be in exact agreement with the results of this study.

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, Regional Director, Region I Office, J. W. McCormack Post Office and Courthouse Building, Room 462, Boston, Massachusetts 02109.

BEST COPY AVAILABLE

8.0 BIBLIOGRAPHY AND REFERENCES

1. New Hampshire Office of Comprehensive Planning, "1976 New Hampshire Resident Population Figures," New Hampshire, 1976.

2. New Hampshire Office of Comprehensive Planning, "New Hampshire Population Projections for Towns and Cities to the Year 2000," New Hampshire, November 1975.

3. New Hampshire Office of Comprehensive Planning, "Existing Land Use - 1975," New Hampshire, April 1976.

4. U. S. Department of Commerce, National Oceanic and Atmospheric Administration, United States Coast Pilot 1, Atlantic Coast, Eastport to Cape Cod, Asheville, North Carolina, National Climatic Center, November 1976.

5. Stone & Webster Engineering Corporation, Development and Verification of a Synthetic Northeaster Model for Coastal Flood Analysis, Boston, Massachusetts, October 1978.

6. Stone & Webster Engineering Corporation, Two Dimensional Coastal Storm Surge Model, SWECO 7501-NP-A, Boston, Massachusetts, July 1977.

7. Tetra Tech, Inc., Coastal Flooding Handbook, Parts I and II, Pasadena, California, May 1977.

8. Stone & Webster Engineering Corporation, Determination of Coastal Storm Tide Levels, Boston, Massachusetts, October 1978.

9. National Academy of Sciences, Methodology for Calculating Wave Action Effects Associated with Storm Surges, Washington, D. C., 1977.

10. Stone & Webster Engineering Corporation, Manual for Wave Runup Analysis, Coastal Flood Insurance Studies, Boston, Massachusetts, November 1981.

11. U. S. Army Corps of Engineers, Galveston District, Guidelines for Identifying Coastal High Hazard Zones, Galveston, Texas, June 1975.

12. U. S. Army Corps of Engineers, Coastal Engineering Research Center, Shore Protection Manual, Volume I, Fort Belvoir, Virginia, 1973.

13. Avis Airmap, Inc., Topographic Maps, Scale 1:2,400, Contour Interval 5 Feet: New Castle, New Hampshire, Project No. 7569, 1977.

14. U. S. Department of the Interior, Geological Survey, Water Resources Investigations 79-61, Coastal Flood of February 7, 1978, in Maine, Massachusetts, and New Hampshire, Boston, Massachusetts, 1979.

BEST COPY AVAILABLE

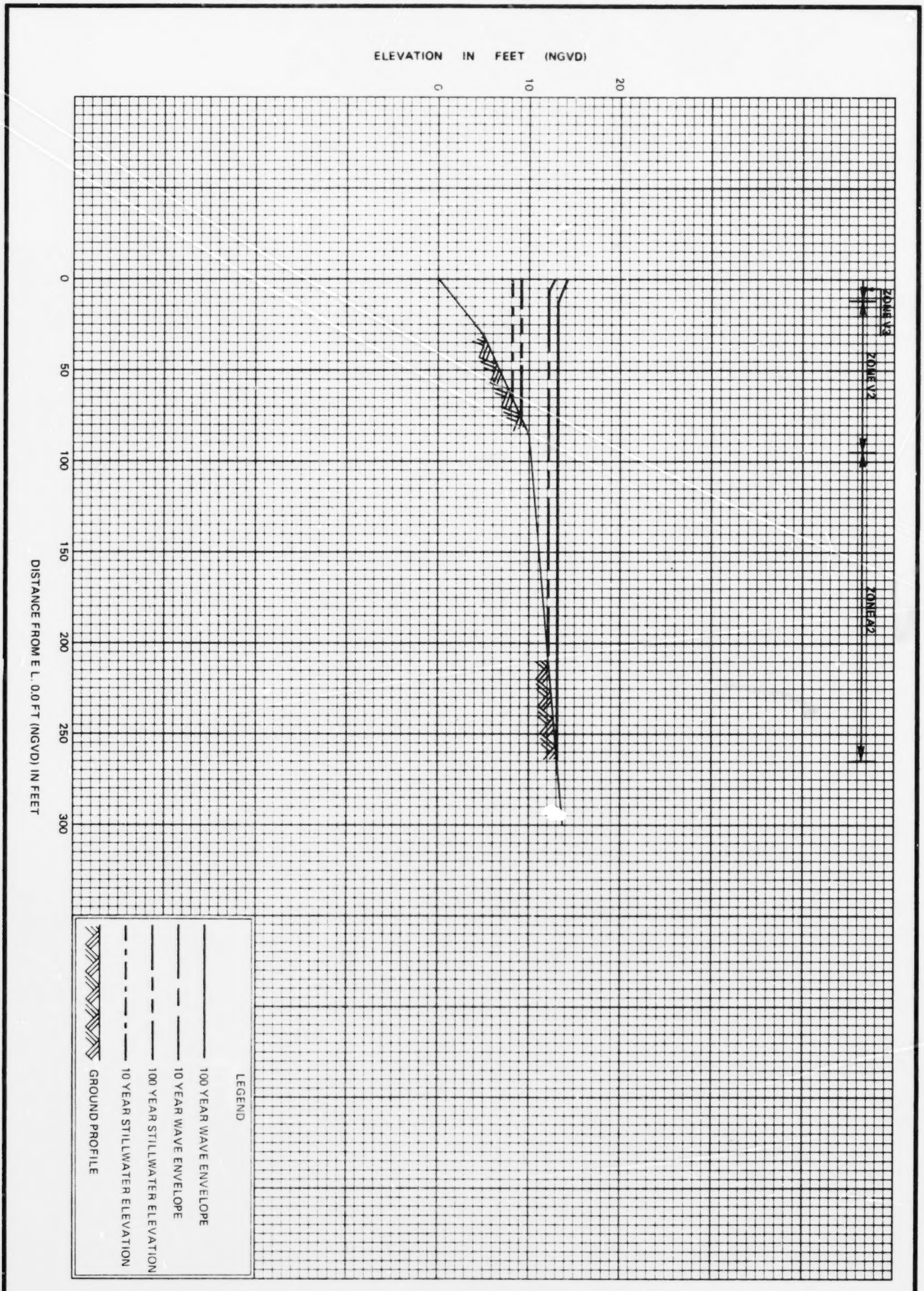
15. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, City of Portsmouth, Rockingham County, New Hampshire, Washington, D. C., November 17, 1981.

16. Federal Emergency Management Agency, Flood Insurance Study, Town of Kittery, York County, Maine, Washington, D. C., April 1, 1983.

17. Federal Emergency Management Agency, Flood Insurance Study, Town of Rye, Rockingham County, New Hampshire (Unpublished).

U. S. Army Corps of Engineers, New England Division, Report on the Assessment of Flood Damage Resulting from the Storm of February 6-7, 1978, along the Coastline from Orleans, New Hampshire, to New Castle, New Hampshire, Waltham, Massachusetts, February 1979.

BEST COPY AVAILABLE



17

FEDERAL EMERGENCY MANAGEMENT AGENCY

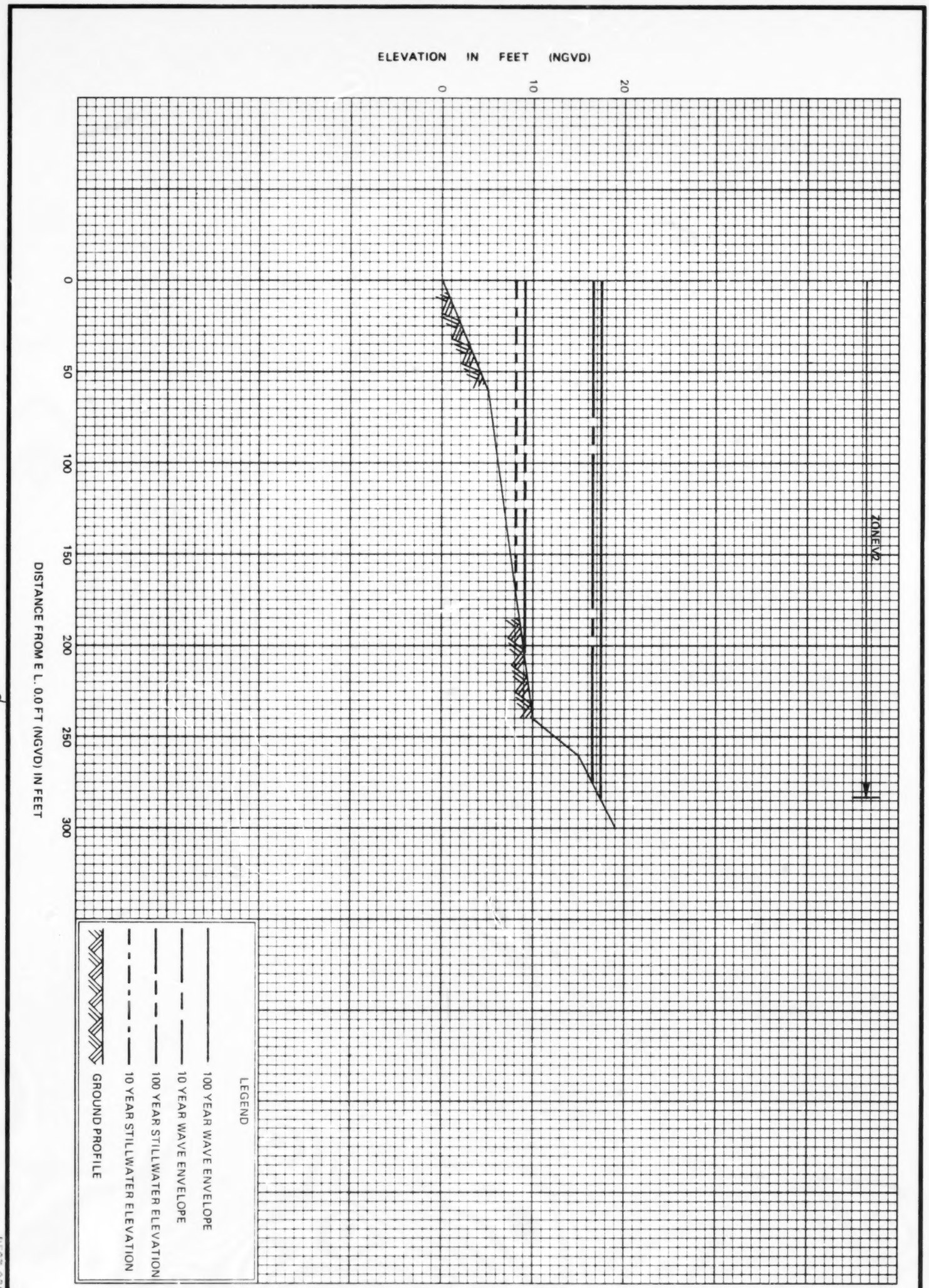
TOWN OF NEW CASTLE, NH
(ROCKINGHAM CO.)

COASTAL PROFILES

TRANSECT 1

01C

BEST COPY AVAILABLE



81

BEST COPY AVAILABLE

02C	FEDERAL EMERGENCY MANAGEMENT AGENCY TOWN OF NEW CASTLE, NH (ROCKINGHAM CO.)	COASTAL PROFILES TRANSECT 2